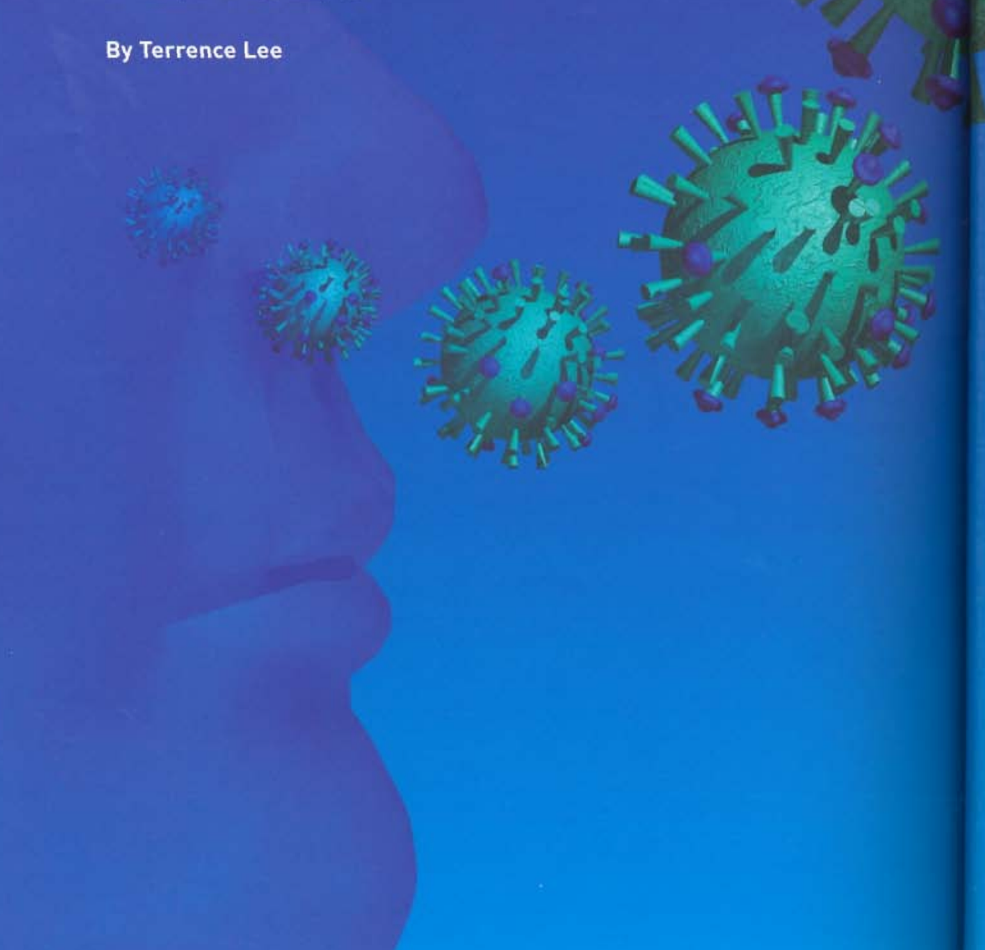

PREVENTING RESPIRATORY DISEASE WITHOUT VACCINES: IS THERE EVIDENCE?

By Terrence Lee

In recent years, the emergence of Severe Acute Respiratory Syndrome (SARS), highly virulent avian influenza in Southeast Asia, and adenovirus has highlighted our lack of preventive countermeasures for acute respiratory disease (ARD) agents. Effective vaccines are not available for avian influenza or SARS and annual influenza vaccine availability and efficacy has been questionable from year to year.

Given these vaccine shortcomings, health authorities have issued nonvaccine recommendations in healthcare settings and nonhealthcare settings to control the spread of infection. These recommendations have included implementation of hand hygiene and restriction or avoidance of close contact with potentially infectious patients. Many of these recommendations have evidence supporting their use in the healthcare setting, but do these interventions work in "community" settings? What is the supporting evidence for these interventions? Are some interventions more effective than others?

Determining the importance of an intervention is difficult because agent transmission and the occurrence of disease depend on many variables. Respiratory disease agents often have more than one route of transmission, such as inhalation and direct contact. Host characteristics relating to immunity vary widely. Agent-specific factors, such as infectious dose and relative efficacy of transmission by different routes, are also important.

We evaluated nonvaccine acute respiratory disease interventions (NOVARDIs) to identify population-based evidence for prevention in nonhealthcare settings, especially military barracks. Although the medical and nonmedical literature has examined many types of control measures, including vitamins and minerals, we limited our search to interventions classified as personal measures (eg, handwashing and use of respiratory masks), administrative controls (eg, decreasing crowding and increasing space allocation per person), and engineering controls (eg, environmental sterilization and air dilution). Our work was published in the April 2005 issue of the *American Journal of Preventive Medicine*.

Personal Measures

Hand hygiene, including the use of traditional soap and water or sanitizing rubs or wipes, has received great attention in the healthcare community. Although compliance is variable and difficult to enforce, there is ample evidence that hand hygiene decreases the incidence of healthcare-acquired infections. The Centers for Disease Control and Prevention (CDC) recommends hand hygiene for the prevention of healthcare-acquired disease and the spread of respiratory agents in healthcare settings. There is also strong evidence that hand hygiene decreases the spread of gastrointestinal diseases.

Unfortunately, only a few well-designed and controlled population-based studies have been conducted in the community setting. For example, an intervention of mandatory handwashing for US Navy recruits resulted in a 45% decrease in annual respiratory disease rates, and self-reported frequent handwashing was associated with lower respiratory disease rates. In an US Air Force randomized, double-blind, clinical trial of antimicrobial handwipes, recruits using wipes experienced a one-third decrease in the number of clinic visits for respiratory disease compared with control subjects. In a civilian study of college students in residence halls, providing students with hand sanitizing gels and handwashing education was associated with significantly lower rates of self-reported colds and influenza-like symptoms.

Theoretical and experimental evidence supports the use of respiratory masks in healthcare settings, but population- or community-based studies are not available. Theoretically, a mask decreases the respirable agent dose to the wearer, thus decreasing disease risk. Masks blocking 95% or more particles of 1 micron or larger are recommended for healthcare providers when caring for tuberculosis patients. Masks can also decrease the amount of particles expelled in the air when an infected person coughs, sneezes, or talks. Masks were often seen in communities where SARS was a threat; however, their efficacy has not been proven. Currently the CDC recommends masks in certain healthcare settings, such as for healthcare personnel who are in close contact with a person who has symptoms of a respiratory infection. No recommendation has been provided for the use of masks by asymptomatic people in communities, such as for the prevention of influenza.

Administrative Controls

Administrative controls involve policy implementation and enforcement. Many administrative controls, such as quarantine, are based on increasing separation between individuals. Quarantine and isolation are used in healthcare settings and were employed during the SARS crisis. However, the effectiveness of these measures is limited because infected individuals may transmit disease agents before symptoms appear.

Cohorting, that is, limiting contact between people of different defined groups, whether infectious or not, has been used and studied. In a school setting, cohorting strategies could include decreasing class sizes and preventing contact between classes. A 1960s study found that US Marines who trained in boot camp in small groups had lower respiratory disease rates compared with US Army and Navy groups who trained in much larger groups. After their initial training, Marines who trained further in larger groups acquired higher respiratory disease rates, similar to those of the Army and Navy disease rates. In recent military respiratory disease outbreaks, possible benefits of cohorting have been inconsistently observed. Effective cohorting may be limited by budgetary constraints, or physical facility size or configuration and may not always be practical.

Crowding is a widely acknowledged risk factor in the transmission of many infectious agents. CDC hospital guidelines call for at least 3 feet between infectious and susceptible patients when private isolation rooms are not available. In other settings where group sleeping quarters are common, such as military, summer, or work camps, strategies such as increasing bed spacing, sleeping in alternate positions (head-to-toe configuration), and use of cloth or other dividers between beds, have been used. The current US Army standard of 72 square feet of living space per person, which can be reduced to 40 square feet per person in emergency situations, is primarily based on tradition. Comfort of inhabitants, rather than disease prevention, dictates the current engineering standard of 50 square feet per person. Population-based studies assessing the efficacy of living-space allocation in disease prevention are few and were conducted many years ago. Sleeping head-to-toe and placing barriers between beds to form mini "rooms" lack population-based evidence to support their effectiveness.

Engineering Controls

Through permanent changes in a physical facility, engineering controls are generally more reliable for implementation, although they are potentially more costly and not necessarily more efficacious. Most engineering controls attempt to act on the infectious disease agent by decreasing the concentration of infectious agent through sterilization, sequestration, or dilution. Two methods of sterilization, ultraviolet (UV) radiation and vapors of glycol esters, have been studied since the 1940s. UV lights are recommended by the CDC as a supplemental engineering control in tuberculosis isolation rooms to improve the effectiveness of other control measures.

Most population-based studies focusing on UV radiation as a preventive measure for respiratory disease have found only a slight beneficial effect; however, a recent study in an office building found a larger effect. Glycol ester vapors, another method studied in the 1940s, were effective in an experimental setting but are deemed impractical today because of concern about chemical exposure.

Microorganisms can be sequestered or blocked by several methods. A sequestering method dating back to World War I is the oiling of blankets and wooden floors, which suppresses dust and theoretically prevents resuspension of infectious material. This method had inconsistent results and today's floors and surfaces should be less conducive to dust accumulation.

A more practical method of reducing the concentration of airborne contaminants is High-Efficiency Particulate Air (HEPA) filtration. HEPA filters have been found effective in filtering out most bacteria under laboratory conditions and are recommended by the CDC in tuberculosis isolation rooms. However, many viruses are smaller than 0.3 microns and HEPA filters are not effective with particles below this size.

As with living-space allocation, dilution ventilation engineering standards are based on comfort, not disease prevention. Increasing ventilation with fresh air leads to lower airborne concentration of pathogens. However, population-based evidence to support dilution ventilation is lacking. New construction may not guarantee a beneficial effect. For example, US Army researchers once observed that recruits who were housed in modern, tightly sealed, energy-efficient barracks had significantly higher ARD rates than those housed in older types of barracks. Unfortunately, adequate quantification of barrack ventilation was not performed in this study.

Conclusions

For practical purposes, we endorse the CDC recommendations for the prevention of influenza, which may also prevent other ARDs. Hand hygiene is one of the CDC recommendations that we reviewed that has supporting theoretical, experimental, and population-based evidence. Measures such as the use of respiratory masks, HEPA filters, UV lights, and increased personal space are recommended in some healthcare settings and deserve further study for use in community settings. Other NOVARDIs that we reviewed, such as respiratory masks and some engineering controls, lack data from population-based studies. Currently, engineering and building standards for living-space allocation and air dilution ventilation should be met, but these should be studied to determine optimal levels to minimize disease. The emergence of respiratory disease agents for which vaccines are not available has awakened interest in NOVARDIs, which should lead to more research and more evidence-based recommendations.

Suggested Reading

American Society of Heating Refrigerating and Air-Conditioning Engineers, Inc. ASHRAE standard: ventilation for acceptable indoor air quality.

Atlanta GA: American Society of Heating Refrigerating and Air-Conditioning Engineers, Inc., 2001 (ANSI/ASHRAE Standard 62-2001).

Boyce JM, Pittet D. Guideline for hand hygiene in health-care settings: recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Infect Control Hosp Epidemiol. 2002;23(suppl 12):S3– S40.

Brundage JF, Scott RM, Lednar WM, Smith DW, Miller RN. Building associated

risk of febrile acute respiratory diseases in Army trainees. JAMA.

1988;259:2108–2112.

Centers for Disease Control and Prevention. Guidelines for preventing the transmission of Mycobacterium tuberculosis in health-care facilities, 1994. MMWR Morb Motal Wkly Rep. 1994;28:1–132.

Centers for Disease Control and Prevention. Centers for Disease Control Web site. Available at: http://www.cdc.gov/flu/.

Gibson RL. Primary prevention of acute respiratory infection amongUnited States Air Force recruits through the use of antimicrobial handwipes–a randomized clinical trial. Report 96-47D. Wright-Patterson AFB OH: Department of the Air Force, January 9, 1997.

Lee T, Jordan NN, Sanchez JL, Gaydos JC. Selected nonvaccine interventions to prevent infectious acute respiratory disease. Am J Prev Med. 2005; Apr;28(3):305-316.

Menzies D, Popa J, Hanley JA, Rand T, Milton DK. Effect of ultraviolet germicidal lights installed in office ventilation systems on workers' health and wellbeing: double-blind multiple crossover trial. Lancet. 2003;362:1785–1791.

Nelson JD. Jails, microbes, and the three-foot barrier. N Engl J Med. 1996;Sep 19;335:885-886.

Ryan MA, Christian RS, Wohlrabe J. Handwashing and respiratory illness among young adults in military training. Am J Prev Med. 2001;21:79–83.

White C, Kolble R, Carlson R, et al. The effect of hand hygiene on illness rate among students in university residence halls. Am J Infect Control. 2003;Oct;31(6):364-370.